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Polarisation of Some Aluminium Alloys in Aqueous Solutions of *n*-Butylamine

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Cathodic as well as anodic polarisation studies of 1060, 1100 and 3003 aluminium electrode have been carried out in aqueous solution of *n*-butylamine using potentiostatic techniques. Active-passive nature of the anodic curves for all aluminium alloys studied has been observed in different compositions of *n*-butylamine solution (from 2 to 0.1%) except in 2% *n*-butylamine solution. Both types of polarisation curves have been shifted towards lower region of current density by increasing water in *n*-butylamine. Lowering of pH values of solution after polarisation studies indicates the adsorption of the studied compound on the electrode surface.

INTRODUCTION

It has been reported by several investigators that lone pair electrons belonging to nitrogen atom of amine play an important role in the inhibition of corrosion of metals.[1–5] But very few attempts have been made to find out the effect thereof on the adsorption behaviour of amine molecules on aluminium surface. In the present paper an attempt has been made to investigate the effect of non-bonded electrons of N atom on the adsorption characteristics of *n*-butylamine on aluminium electrode surface during polarisation studies using potentiostatic techniques. In addtion to this, the present paper also reports about the role of water in the polarisation behaviour of aluminium in *n*-butylamine.

EXPERIMENTAL

1060, 1100 and 3003 aluminium alloys were supplied by Hindustan Aluminium Corporation Ltd., Renukoot, Sonbhadra, India to make a flag-shaped electrode of area 10 × 10 mm. The percentage composition of these alloys, process of specimen preparation, the details of the method for anodic and cathodic polarisation studies were reported in the earlier publication.[3] Test solutions of concentration ranging from 2 to 0.1% were made in triply distilled water using AR grade of *n*-butylamine. Digital pH meter was employed to measure the pH of the solution after polarisation experiments. All measurements were recorded at 35 ± 0.2°C in an air thermostat.

RESULTS AND DISCUSSION

The values of various parameters for 1060, 1100 ad 3003 aluminium electrodes in different concentrations of *n*-butylamine are shown in Table-1. In case of steady state corrosion potential (E_{cp}) and primary passivation potential (E_{pp}) an increas-

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ing tendency has been observed with dilution of *n*-butylamine. Break down potential (E_b) is not detected for all studied alloys in 2% composition of test solution. It is further seen from the table that this potential increases whereas critical current density (I_c) and pH of test solution measured after polarisation studies fall off as the concentration of *n*-butylamine decreases. The results of polarisation studies are displayed in Figs. 1–4. The plots of anodic and cathodic polarisation for 1060 and 1100 are not shown here because of the fact that they are something similar to the given plots. It is evident from these figures that by increasing percentage of water in *n*-butylamine both types of polarisation curves shift towards lower region of current density on changing potential. *n*-Butylamine combines with water to form *n*-butylammonium ions ($CH_3CH_2CH_2CH_2N^+H_3$). It is expected that these ions containing positive charge on N atom may unite with water molecules through hydrogen bonding. In case of cathodic polarisation such ions, associated with water molecules, get attached to the cathodic points of the electrode surface *via* nitrogen atom carrying positive charge. On the other hand during anodic polarisation studies the same ions may adhere to the anodic points *via* oxygen atom of water molecule rich in non-bonded electrons. Because of this, the electrode surface is covered by a film consist of *n*-butylammonium ion bonded with water molecules. As a result, the formed film enhances resistánce; therefore, current density moves towards lower region with water percentage. The decreasing magnitude of pH of test solution measured after polarisation studies ascertains

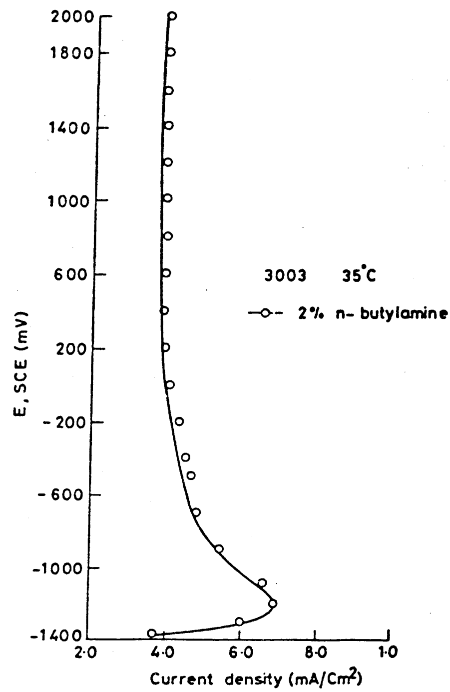

Fig. 1. Anodic polarisation curves for 3003 aluminium in 2% *n*-butylamine at 35°C

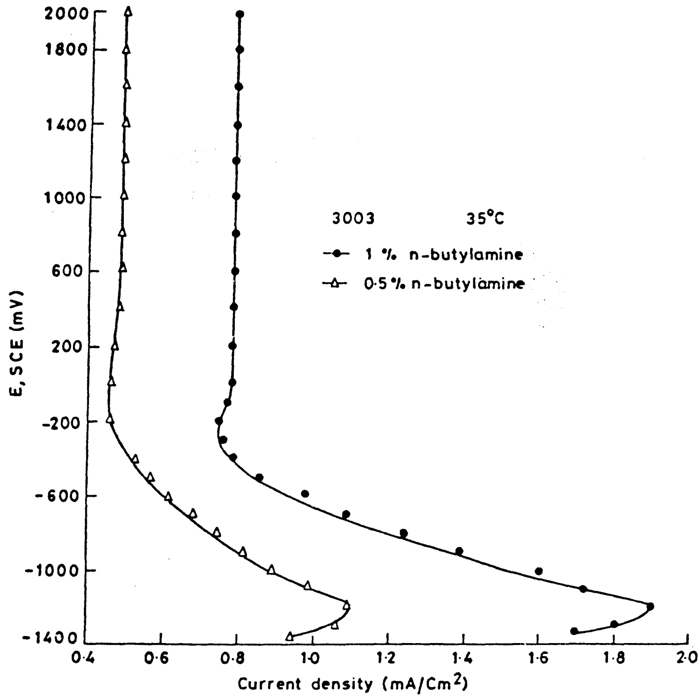

Fig. 2. Anodic polarisation curves for 3003 aluminium in 1% and 0.5% *n*-butylamine at 35°C

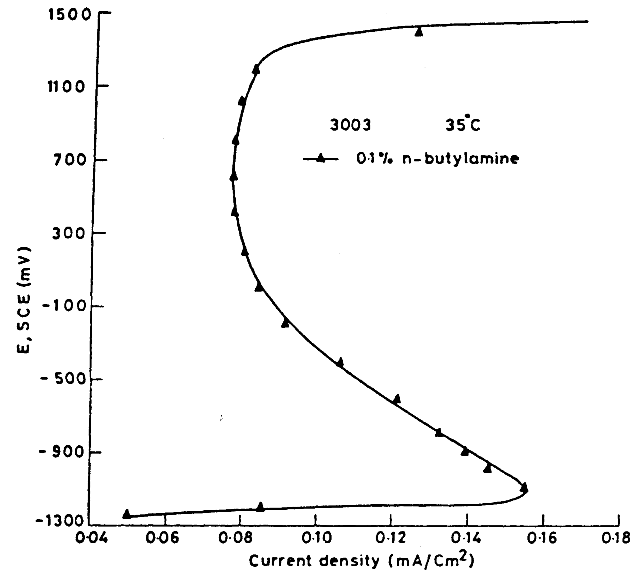

Fig. 3. Anodic polarisation curves for 3003 aluminium in 0.1% *n*-butylamine at 35°C

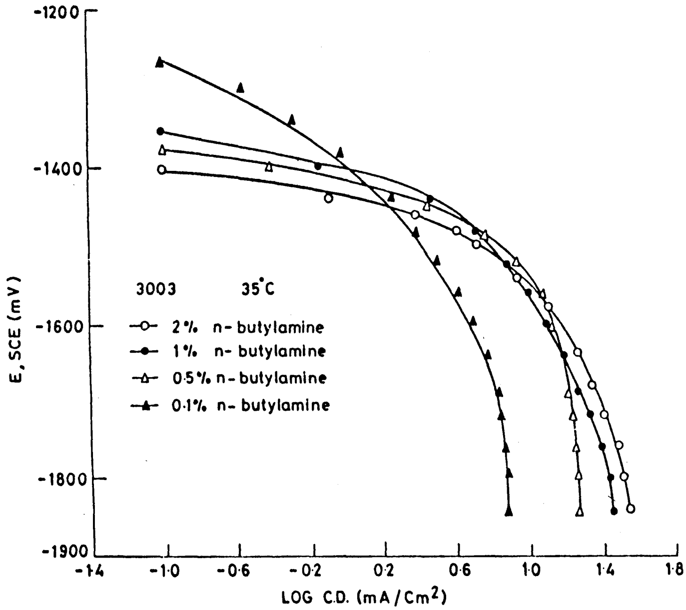

Fig. 4. Cathodic polarisation curves for 3003 aluminium in different compositions of *n*-butylamine at 35°C.

and supports the above reasoning. It may also be concluded from anodic polarisation curves that current density decreases after primary passivation potential. This indicates that *n*-butylamine molecules get adsorbed on base aluminium *via* N atom using lone pair of electrons present on it. Ensue of this fact a film forms on the electrode surface wherefore current density decreases.

TABLE-1
STEADY STATE CORROSION POTENTIAL (E_{cp}), PRIMARY PASSIVATION POTENTIAL (E_{pp}), BREAKDOWN POTENTIAL (E_b) AND CRITICAL CURRENT DENSITY (I_c) OF 1060, 1100 AND 3003 ALUMINIUM ELECTRODE IN AQUEOUS SOLUTION OF *n*-BUTYLAMINE AND pH OF SOLUTION AFTER POLARISATION STUDIES AT 35 ± 0.2°C

Alloys and solution composition	E_{cp} (mV)	E_{pp} (mV)	E_b (mV)	I_c mA/cm^2	pH
1060					
2% *n*-butylamine	−1600	−1100	—	6.600	11.10
1% *n*-butylamine	−1520	−1100	−200	2.475	10.75
0.5% *n*-butylamine	−1580	−1000	−100	1.700	10.74
0.1% *n*-butylamine	−1410	−1000	+ 400	0.234	10.33
1100					
2% *n*-butylamine	−1570	−1200	—	7.450	11.16
1% *n*-butylamine	−1540	−1100	−300	2.220	10.74
0.5% *n*-butylamine	−1580	−1100	−300	1.540	10.59
0.1% *n*-butylamine	−1410	−1100	+ 800	0.240	10.24

Alloys and solution composition	E_{cp} (mV)	E_{pp} (mV)	E_b (mV)	I_c mA/cm^2	pH
3003					
2% *n*-butylamine	–1380	–1200	—	6.750	11.15
1% *n*-butylamine	–1330	–1200	–200	1.900	10.64
0.5% *n*-butylamine	–1340	–1200	–100	1.090	10.46
0.1% *n*-butylamine	–1200	–1100	+ 600	0.155	10.22

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